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ABSTRACT

This study was designed to investigate the effects of the presence or absence of metacognitive skill tools available in hyperspace environments on field independent and field dependent learners. Learners were engaged in problem solving in an information-rich hyperspace based on a lesson on the attack on Pearl Harbor. Forty undergraduates were given the Group Embedded Figures Test to determine field dependence or field independence. In some conditions, students had access to metacognitive skill tools through the menu. These were intended to help students structure their problem-solving paths. Information acquisition paths learners took through the problem solving were automatically recorded and investigated, and student solutions were analyzed to determine recall and cognitive complexity. Results indicate that the use of metacognitive tools does not contribute to better learning with hyperspace. Cognitive style did not affect students' navigational paths. Field dependent people monitored the instructional goal and used guided questions more often than field independent people, but they did not demonstrate better performance. Six tables present study findings. (Contains 36 references.) (SLD)

Title:

Effects of Learner Cognitive Styles and Metacognitive Tools on Information Acquisition Paths and Learning in Hyperspace Environments

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INTRODUCTION

Purpose

This study was designed to investigate the effects of the presence or absence of metacognitive skill tools available in the hyperspace on both field independent and field dependent learners. The learners were engaged in problem solving in an information rich hyperspace based on a lesson of the attack on Pearl Harbor. They were given the Group Embedded Figures Test (GEFT) in order to identify those who were predominately field independent and those who were predominately field dependent. The information acquisition paths that the learners took through the problem solving were automatically recorded and investigated. The students' solutions to the problem solving task were analyzed to determine the recall of the content and the level of the cognitive complexity based on the quality and the processes used to reach the conclusions. In addition, the amount of time spent on the key information (depth of information processing) was recorded within the audit trails so that the information processing time by different learners was identified as well. The significance of the research findings for instructional courseware designers as well as implications for future study is discussed.

Theoretical Framework

Metacognition and Learning

The theory of metacognition is concerned with the individual's awareness, planning, and control over cognitive process and learning activities (Swanson, 1990; Haller, Child & Walberg, 1988; Flavel,1979). Metacognitive strategies such as teaching learners knowledge about what reading strategies to use and how and when/why to use them produce reading comprehension (Haller, Child & Walberg, 1988). In addition, studies indicated that subjects required to explain reasons for actions while solving problems demonstrated a positive transfer of tasks (Stinessen,1985). Lin (1993) compared metacognitive groups with cognitive, affective, and control groups. She found that metacognition had a significant positive impact on students' transfer of the problem solving tasks. It was suggested that metacognitive processes made students focus on and become consciously aware of the solution components. Because of this, learners were able to attend to information regarding the way to solve a problem. Unfortunately, it appears that metacognitive processes do not take place spontaneously. It requires the development of awareness of task, strategy, and performance (Wade & Reynolds,1989). Learners may also gain metacognitive skills through the teacher's modeling or guided practice (Billingsley & Wildman, 1990), prompted cues (Lin, 1993), or self-questioning (Wade & Reynolds, 1989). However, the existing instructional design models do not typically emphasize metacognitive strategies such as planning, monitoring, revising, and other self-regulating activities. (Osaman et. al. ,1992).

Field dependence/field independence

Cognitive style refers to an individual's characteristic approach(es) to perceiving, processing, and organizing information. It was proposed that the construct field-dependent/independent is one of the cognitive styles most significant to education problems and has been more extensively researched (Chinnien & Boutin, 1993). Research indicated that the field independent style is mostly related to the ability

to perceive a particular relevant item in a "field" of distracting items. Conversely, field dependent people tend to be dependent on the total field and hence the parts embedded within the field are not easily perceived (Brown, 1987). As a result, compared to field independent learners, field-dependent individuals are more likely to have greater difficulty in learning when the learner himself/herself is required to provide organization as an aid to learning. (Wiktin, Moore, Goodenough & Cox, 1977). Davis (1989a) added in a review of studies on field-dependence that the field-dependent learner is more reliant on salient cues in learning. Davis further suggested incorporating metacognitive skills into future learning research of field-dependence/independence (Davis, 1989b).

Navigational paths of information in hyperspace

Hypermedia systems integrate text, sound, graphics, and video (Ayersman, 1993; Wang & Jonassen, 1993) to present the knowledge within the network of ideas or use nodes and links to organize structure (Spiro & Jehng,1990). The emergence of hypermedia has fostered the computer-based learning a much freer and richer environment which provides freedom to the user to explore (Staton, & Barber, 1992). Unlike traditional learning environment, it appears that hypermedia learning is self-directed. With this system, the responsibility for identifying what is useful information and selecting search strategies for accessing that information is largely left up to the user (Small & Grabowski, 1992). Therefore, the learner or the user is required to interact and explore the information by developing their own paths or knowledge structure.

Due to the user-oriented nature of hypermedia, the learners need to decide where to retrieve information, what strategies to use for problem solving, and why or when to quit the environment. It is thus believed that metacognitive knowledge and skills are essential for successful in hypermedia system (Lin, 1993) because in the metacognitive process the learners need to plan for cognitive actions, monitor their progress, and reflect upon and regulate their own learning process (Rowe, 1988; Cardelle-Elawar, 1992). While it was proved that metacognition played an important role in oral comprehension, reading comprehension, problem solving, memory and the like (Flavel,1979), the research findings also showed that incorporated metacognitive strategies in hypermedia learning would enhance problem solving and transfer of tasks (Lin,1993).

The literature has shown that the hypermedia system eliminates linear linkage of text and allows users to freely browse through a knowledge base (Nelson & Palumbo, 1992). Yet, it has been observed that learners' motivation may be impaired if they become overwhelmed by the freedom in the hypermedia environment (Staton & Barber,1992). The recent development of hypermedia has henceforth put more concern on issues of navigational problems and the search strategies by different individuals. Jonassen (1988) advocated that it is important to investigate how learners navigate through hypermedia systems and how individual differences could predict those paths.

In concert with the above concerns, the present study demonstrates the significance of studying how field dependent and independent learners interact with the hypermedia system. It is especially important to explain whether metacognition plays an influential role for individual differences in cognitive style if the individual is cued to consider, as well as, evaluate his or her thoughts by an available tool to process metacognition during the problem solving process in a hyperspace environment.

Statement of research problems

This research study aimed to investigate how field dependent and field independent people respond to the presence or absence of metacognitive skill tools in information-rich hyperspace. The hyperspace is defined here as loosely structured hypermedia where text, charts, document, and graphics were integrated and hyperlinked (Chung, Frederick, Hsu, 1994). In the hyperspace environment, the expert structure was not created by the developers or programmers. The subjects were expected to bring their own expert systems of structure to solve the problem. This research investigated the following research problems:

1. Will the presence of metacognitive skill tools have an effect on field dependent or field independent learners' recall of content and level of thinking process while providing solutions to the problems?
2. Will the presence of metacognitive skill tools have an effect on field dependent or field independent learners' depth of information processing?
3. Will the presence of metacognitive skill tools have an effect on field-dependent or field independent learners information seeking paths?

Significance of the Problem

The infusion of computer-based interactive hypermedia into instructional environments has made a dramatic change in education. Since then, the professionals have been investigating how interactive hypermedia materials might be designed so that they are developmentally appropriate. Jonassen (1988) proposed his insight into maximizing the hypertext learning. He said that a path analysis program needed to be developed to identify any prominent access path learners take through hypermedia environments. He also suggested relating the access paths to different learning styles. The advocation by Jonassen serves the basis of rationale for this study.

Aust and Klayder (1990) have a concern about an overabundance of information and predict that it may result in "information anxiety or knowledge starvation". In fact, often learners have a tendency to become lost or disoriented while using hypermedia environments. Specifically, it was found that "individuals often encounter loosely-structured information environments wherein there are no clear questions to be answered" (Chang & McDaniel, 1993). It is suspected that this problem could be related to a variety of learner characteristics. It is possible that the "learners lost in hyperspace" may be predominantly field dependent learners since field dependent people have difficulty with providing organization to learning (Wiktin et. al., 1977). In particular, it is predicted by the researchers that field dependent people may become efficient learners if metacognitive tools are provided in the hyperspace environment. Based on the research assumptions, it is important to prove the hypothesis to determine if the integration of metacognitive skill tools is a viable method for developing a better hyperspace environment for different learners. Moreover, since hyperspace is a loosely-organized hypermedia, the students are not provided with "expert structure" to the system. Conversely, the students need to develop their own structure of navigating, seeking and processing information in hyperspace. The findings of this study would have significant contribution to determine what an expert's structure is and thus help to develop a hypermedia learning environment.

METHODOLOGY

Subjects

Forty undergraduate students who were registered in an introductory computing course at a midwestern university participated in this study. The students automatically earned credits toward their course grade for participation. There were two males among the subjects. There was one subject whose ethnic origin was Asian and the rest were Caucasians. The computer experience reported by the subjects varied from fair to excellence. The familiarity of the research content, Pearl Harbor, ranged from fair to average.

Material I

In this study, a lesson called "Asleep at Dawn--The Attack on Pearl Harbor" was constructed on a Macintosh Hypercard stack by one of the researchers. This lesson provides a wealth of information about the Pearl Harbor attack. The content materials were based on the following books: *Pearl Harbor Final Judgment* (Clausen, H. & Lee B., 1992), *America Goes to War 1941* (Devaney, J., 1991), *And I Was There* (Layton, E. at el. 1985), *Pearl Harbor* (Shapiro, W. 1984), and *79th Congress of United States of America* (1946).

The materials were presented with the following distinctive features. First, the subjects were provided the introduction to the lesson. They were requested to play a role as an investigator to investigate the events surrounding the bombing of Pearl Harbor. Second, the main body of information about the Pearl Harbor attack was presented via hyperlinks (Appendix I). There are twenty topics that can be chosen from the main menu. Access to information chosen by the individual reflects his or her own paths and speed of searching for information among the topics. The subjects could quit whenever they felt they had enough information for the conclusions of their investigation. Third, there is a menu topic called "Four Key Questions" embedded in the main menu. The "Four Key Questions" comprises four questions which serve as guided clues to stimulate the subjects' critical thinking. In addition, a menu called "Mission" was created and placed on the menu bar. The "Mission" menu describes the tasks that the subjects need to accomplish throughout the Pearl Harbor lesson. Fourth, there are some cards with three asterisks labeled to denote that these cards contain key information for answering questions in the conclusions. Fifth, there are two questions posed in the conclusions where the subjects needed to determine the critical events that caused the attack and whom should be blamed. When the subjects clicked "Done" on the menu, the conclusion screen was provided and the subjects needed to supply their answer. This stack also includes a path tracking mechanism which records simultaneously the paths chosen by the subjects and time used by the subject for each level of information access.

In this study, even though either the "Four Key Questions" or "Mission" function as guidance which will help the subjects form an expert's knowledge structure in the hyperspace, the subjects were not particularly informed about why and when to get access to this information.

Material II

This lesson has everything covered in Material I except that Material II has metacognitive tools available on the menu bar called META. The META tools posed four different questions at one time. For each selected question, the subjects were prompted to enter their plans for the investigation and their reason for this

particular plan (Appendix II). The plan and reason are not the answer to the question being posed but rather the students' current thought and actions taken to accomplish the investigating task. In other words, the questions were intended to help the subjects structure their paths of searching the information. The subjects had to check the META menu periodically until all four questions were selected. Unlike Material I, subjects using Material II were required to use the expert questions and to enter their metacognitive processes in terms of their plans and reasons for the plans.

Data Collection

Independent Measures

The Groups Embedded Figures Test: The Group Embedded Figures Test was administered before the treatment to measure the learners' cognitive styles. The GEFT has been used widely as a valid and reliable instrument to assess the cognitive style (Small & Grabowski, 1992).

Treatment Conditions: The subjects were randomly assigned to different treatment conditions during the hyperspace problem solving session.

1. Field dependents with metacognitive tools available (Experimental group).
2. Field independents with metacognitive tools available (Experimental group).
3. Field dependents without access to metacognitive tools (Control group).
4. Field independents without access to metacognitive tools (Control group).

Dependent Measures

This study attempted to investigate the effects of the presence or absence of metacognitive tools in the hyperspace environment on field dependents' and field independents' recall of content, level of cognitive process, depth of information process, and information seeking strategies.

1. Recall of content: The conclusions provided by the subjects were evaluated from two aspects: recall of content and level of cognitive process. A checklist of the critical events which caused the Pearl Harbor attack, or key characters who should be responsible for the surprise attack was developed by the stack developer as the scoring criteria for the recall of the content.

2. Cognitive complexity: The approach to scoring subjects' cognitive complexity on conclusion was to read them holistically and examine the reasons supporting their position. The conclusions were rated on a scale of one with simple description of the fact to five with integrated analysis of learning content. This rating scale was used to determine the cognitive complexity which was developed by McDaniel and Lawrence (McDaniel & Lawrence, 1990). Due to the subjective nature of essay tests, two independent scorers were involved to gain interrater reliability in scoring.

3. Depth of information processing was determined by time spent on each key information denoted by three asterisks. The key information was considered providing useful content for drawing conclusions of investigation.

4. Information Seeking Strategies were identified by the mean time learners spent on searching for a topic, the subjects' frequent use of the "Mission" menu and "Four Key Questions" as monitoring guidance, and descriptive data of the subjects' audit trails to reveal individual's navigational patterns. Qualitative analysis of the subjects' exit questionnaire was conducted as a support of the empirical data.

Pilot Study

Before the actual experiment, a pilot study was administered to confirm that no problems existed in the hypercard program or in the exit questionnaire. A student with similar background of the anticipated subjects volunteered to participate. Some minor changes were made according to the results of the pilot study.

Procedures

The whole experiment is divided into two sessions held on different days. The first session was scheduled for assessing the students' cognitive styles. The whole process of assessment was timed based on the instructions in the manual. Based on the scoring result, forty subjects (field independency =20; field dependency= 20) were selected and randomly assigned to one of four different experimental conditions. The experiment proceeded in the same location but different rooms for control and experimental groups respectively. Before beginning the lesson, all students were given a group orientation to the lesson by the researchers. The subjects were briefed on the use of buttons in hypercard and their mission throughout the lesson. People in the experimental group were also told to use the metacognitive tools available on the menu bar. Once instructed to start, the subjects in both groups worked individually in separate rooms. The whole computer lesson lasted approximately from one to one and half hours. Upon completion of the lesson, the subjects filled out an exit questionnaire.

Data Analysis Tools

The subjects' audit trails of working with the hyperspace were collected and analyzed by a statistical software package called StatView SE+. ANOVA tables were obtained to determine the main effects and the interaction between the two independent variables on the dependent variables. In addition, a thorough examination of the subject' paths and self-reported searching strategies were analyzed through a qualitative approach.

RESULTS

Recall of the Content

The ANOVA table concerning students' recall of content are presented in Table 1. The mean scores between the groups that received the metacognitive tools and those who do not have the access are not significantly different ($F=1.054$, $p=.3107$). Students performed similarly on the recall of content regardless of the availability of the metacognitive tools in the hypermedia learning, however, a significant main effect was found for the cognitive styles ($F=6.475$, $p=.015$). The field independent people outperformed the field dependent people in recalling the content. No interaction between treatments and cognitive styles was found.

Cognitive Complexity

A significant main effect was found for the treatments (Table II). Students who are not provided with metacognitive tools demonstrate a higher level of thinking in drawing conclusions than those who have access to the metacognitive tools ($F=4.523$, $P=.0[illegible]97$). The mean scores of the field independents are found to be significantly higher than the field dependents ($F=8.551$, $P=.0057$). No interaction exists in this particular dependent variable.

Depth of information processing

There is no main effect found in the depth of information processing (Table III). Students spent approximately the same amount of time processing the key or critical information regardless of the cognitive styles or treatments that students were receiving. It was found, however, that there is correlation existing between the recall of content and the number of cards that had been read ($r=.265$, $p<.05$)(Table IV a). The students' level of cognitive complex shown in the conclusions is also correlated with total cards that were read ($r=.294$, $p<.05$) (Table IVb.).

Information Seeking Strategies

The searching strategies were studied from three perspectives: time on searching (how much time was spent on deciding on a topic), frequent use of monitoring or guidance (how often did the students check the "Mission" menu or "Four Key Questions") and navigational patterns (in what order the topic was accessed). No statistical main effects were found between the groups in spending time in deciding a topic from a variety of options on the main menu (Table V).

Even though no significant result was indicated on the frequent use of monitoring between the groups, there was a moderate difference in the use of monitoring by field independents and dependents ($P=.081$, $p<.1$)(Table VI). The field dependent people tended to constantly check their instructional objectives (Mission) and using guidance (Four Key Questions) more often than did the field independents throughout the hyperspace problem solving session.

As the subjects' audit trails were analyzed, a detailed picture of the navigational patterns emerges. There were three most prevalent navigational patterns: 1. Linear access: The subjects chose the topics on the main menu in the order of top to bottom or left to right (as defined by Small et. al., 1992; Chung et. al., 1994) 2. Non-linear access: The subjects chose the topics without any distinctive structured manners. The orders were jumped around. 3. Cycle access: The navigation in the hypermedia falls into a cycle pattern. The subjects kept going back and forth among the chosen topics. The navigational patterns only reveal the individual preferences of information access. The finding did not indicate that particular patterns emerged due to differences in cognitive styles or the manipulation of the treatments. It is worthy of notice, however, that five out of the top eight people who scored both high on recall of content and cognitive complexity tended to navigate linearly in the hyperspace.

Exit Questionnaire

Self reported searching strategies. In addition to the quantitative data, data gathered from the questionnaire were analyzed to provide an in-depth and valid interpretation of the students' information searching strategies. The major assertion generated from the students' report was that they selected the paths based on the condition that the information was vital to provide valuable knowledge for their conclusions.

> *"I chose what seemed to be the next important information."*
> *"I asked myself what kind of information I am going to find, how this information would help me in finding out more about the attack."*
> *"I chose the next path if it seemed like the information would be helpful for me in solving this problem"*

Another common strategy employed by the students was that they chose the paths which contained information pertinent to what they had previously known.

"(I chose the path based on) what I have previously found out"
"It seemed important to choose the next item that was somewhat related to the one I just looked at"

The use of the metacognitive process demonstrate an indicator of the students' strategies for searching information. The students' plans and explanation for planning revealed what is the next path she or he is going to take.

"I plan to find out what Pearl Harbor knew about what the Japanese were planning on doing. I want to do it this way so I can try to figure out why they withheld information about the intentions of the Japanese."

"I want to investigate on those individual leaders who seem to have some connection with the Japanese. If there was anyone in Washington that knew anything about the plans, I have to investigate all of the main people in charge of US operations. By looking indepthly at these various leaders, hopefully I can gain some clues on where information on Japanese plans"

In addition, there were some students who employed the guided questions to direct them to the next path.

"(I chose the next path for) gaining information that would provide answers to the questions."
"At first I wanted to find the important people. Then I just clicked around to find the answer to the key questions"

As expected, some people got lost in searching the information. These people did not demonstrate any strategies in their report.

"I was pretty random in my selection. Once again, I didn't have enough background information to have a real direction."
"Whether or not to go on"
"How to get back to the main menu."

Attitude toward metacognitive use: Descriptive data were obtained with regard to students' attitude toward the use of metacognitive tools in hypermedia. The assertion drawn from the analysis was that the students conceded that planning help them structure knowledge about the conclusions, yet, they found they were still not skillful at using their "working mind." Some comments related to this assertion are:

"Yes, I think that meta is people's working mind. It helped me form my ideas to write the conclusion, because it helped me formulate the questions that I wanted to ask at the end, and it also helped me write on the topic given."

"I do think it (metacognition) offered me some hints to get conclusion. However as far as the case "Pearl Harbor" was concerned, it's hard for me to make initial plans without a clear introduction. That is to say I need more knowledge about the background information. "

"I thought it (metacognition) was confusing, but I am not used to working on a computer, so it is all kind of strange. I think planning out your thoughts is very important, but I am just not familiar with the material or the computer"

DISCUSSIONS

Research findings in this study indicated that the use of metacognitive tools did not contribute to the students' better learning with hyperspace. On the contrary, when the students' cognitive complexity was evaluated based on their conclusions, the control groups outperformed the experimental group. In other words, the students did not benefit from planning or explaining their thinking process during the problem solving tasks. Through analyzing the students' protocols, one thing remains evident. It appears that the lack of prior knowledge about the lesson plays a vital role. Students' metacognitive process were carefully screened by looking through their plans and explanations. One student wrote all the way through in her planning: "*To get more information.*" Another student expressed her opinion on planning, "*without background or introduction, it is very hard to form an initial plan.*" When the student is lacking background knowledge, she or he will not have the knowledge foundation from which actual plans can be built up.

Small et. al. (1992) advocated that the decisions the students make are influenced by one or more personal or environmental constraints, such as prior experience, or the type or amount of information available. Their advocation demonstrated that the prior experience or knowledge brought by the students has influence on students' interaction with hypermedia learning. The implication of this result in this study is that there is a need for future research to investigate how to activate the students' prior knowledge or their "schemata" in the hypermedia learning environment.

Another explanation for the non-significant results of using metacognitive tools in the hypermedia could be that the students are still not familiar with the use of metacognitive strategies or are not used to employing the strategies in their learning. While some students felt that metacognition would help them form their knowledge structure, other students stated that they still did not know what metacognition was. This finding implies that more time on training student's metacognitive strategies is needed. Lin (1992) cites the work of DeStefano and Gordon (1986) and points out that the idea of training individuals to employ metacognition has been stimulated from the findings that many individuals cannot independently produce effective learning strategies or realize when, where and why to apply known strategies, but they can use learning strategies when instructed to do so. The length of time on training to achieve maximum outcome is still in need of investigation.

The findings do not indicate any significant difference in the depth of information processing between the treatment groups. This result implies that the learners spend the same amount of time on reading the information which will provide important clues for investigating tasks. The number of cards that the students went through; however, was correlated with the recall of the content and higher level of thinking process. In other words, the more the students spent time reading the information, the more the students could recall and the higher thinking level they were able to achieve. Future research which investigates how to motivate the learners to better spend their time in the task could definitely improve effective hypermedia learning.

The research finding shows that neither cognitive styles nor the experimental treatment (i.e. metacognitive tools) have an effect on students' navigational paths.

Both groups of people spent equal amount of time searching for a topic. Yet, the analysis of students' protocols show that the use of the metacognitive process helped the students structure their searching strategies. As to the navigational patterns, a trend indicates that people who are ranked in the top on their posttest (i.e. drawing a conclusion) tend to navigate linearly through the paths (i.e. to choose the topic in the order of top-bottom or left-right). Even though the trend needs more supportive empirical data or in-depth investigation of students' self-reported description, it appears that the assumption proposed by Spiro et. al.(1990) that linear organization may not permit or encourage the learners to learn by exploring in their full complexity requires further study . Since hypermedia are featured by the nonlinear structure, it is suggested to investigate how to organize the information in order not to discourage the students from a non-linear hypermedia environment especially when they are required to self-control the pace and paths.

Even though the field-dependent people constantly monitored the instructional goal or used guided questions relatively more often than did the independent people, the field dependent people did not demonstrate better performance in drawing conclusions. The reason behind this finding is unknown. Yet, Jonassen & Wang (1992) found out that the field independent learners were better hypertext processors, especially as the form of the hypertext became more referential and less overtly structured. With loosely-structured hypermedia like hyperspace in this study, Jonassen et. al.'s finding appeared to explain why field dependent people employed the monitoring strategies yet they still could not process the information as well as the field independents. The research findings by Weller et. al. (in press) could support the explanation for relatively poor performance of the field dependents as well. Weller et. al. pointed out that "field independent students learned computer ethics more effectively than did field dependent, even when field dependent students were provided with 'help' such as advance organizers and/or graphical organizers". As the researchers voice their concern about learner differences and hypermedia learning (Ginsburg & Zelman, 1988; Wang & Jonassen, 1993), there is a large research area left for those who are interested in hypermedia learning and learner characteristics to explore .

The use of hyperspace learning environment in this study helps to shape the instructional developers' view on how people bring their own knowledge structure into learning. The findings about the students' navigational strategies, paths of information processing in the system interacting with different cognitive styles and metacognition would be beneficial to the educators as well as courseware designers.

Table I: Effects on recall of the content

ANOVA table for a 2-factor Analysis of Variance on Y

Source	DF	Sum of Squares	Mean Squares	F-test	P value
Treatment (A)	1	12.023	12.023	1.054	0.3107
Cognitive Styles (B)	1	73.841	73.841	6.475	0.015
AB	1	19.114	19.114	1.676	0.203
Error	40	456.182	11.405		

The AB Incidence table on Y: Recall of content

	Dependent	Independent	Totals:
Meta	n=11 mean=4.364	n=11 mean=8.273	n=22 mean=6.318
Non-Meta	n=11 mean=4.636	n=11 mean=5.909	n=22 mean=5.273
Totals:	n=22 mean=4.5	n=22 mean=7.091	n=44 mean=5.795

*scores (0-31) on the conclusions for the recall ability

Table II: Effcts on cognitive complexity

ANOVA table for a 2-factor Analysis of Variance on Y

Source	DF	Sum of Squares	Mean Square	F-test	P value
Treatment (A)	1	5.818	5.818	4.523	0.04
cognitive Styles (B)	1	11	11	8.551	0.006
AB	1	3.273	3.273	2.544	0.1186
Error	40	51.455	1.286		

The AB Incidence table on Y: cognitive complexity

	Dependent	Independent	Totals:
Meta	n=11 mean=1.182	n=11 mean=2.272	n=22 mean=1.955
Non-Meta	n=11 mean=2.455	n=11 mean=2.909	n=22 mean=2.682
Totals:	n=22 mean=1.818	n=22 mean=2.818	n=44 mean=2.318

*scores (0-5) on the conclusions for cognitive complexity

Table III: Effects on depth of information processing

ANOVA table for a 2-factor Analysis of Variance on Y

Source	DF	Sum of Squares	Mean Square	F-test	P value
Treatment (A)	1	90.213	90.213	0.592	0.446
cognitive Styles (B)	1	46.25	46.25	0.303	0.585
AB	1	9.227	9.227	0.061	0.807
Error	40	6099.548	152.489		

Table III: Effects on depth of information processing (continued)

The AB Incidence table on Y: depth of information processing

	Dependent	Independent	Totals:
Meta	n=11 mean=24.317	n=11 mean=27.28	n=22 mean=25.797
Non-Meta	n=11 mean=22.366	n=11 mean=23.5	n=22 mean=22.933
Totals:	n=22 mean=23.34	n=22 mean=25.39	n=44 mean=24.365

*time (seconds) deveoted to reading relevant and key information

Table IVa: Correlation between number of cards (X) and recall of content (Y)

Count	Covariance	Correlation	R-Squared
44	76.07	0.265	0.07

Table IVb: Correlation between number of cards (X) and cognitive complexity(Y)

Count	Covariance	Correlation	R-Squared
44	27.121	0.294	0.087

Table V: Effects on time on searching for a topic

ANOVA table for a 2-factor Analysis of Variance on Y

Source	DF	Sum of Squares	Mean Square	F-test	P value
Treatment (A)	1	66.568	66.568	1.368	0.249
cognitive Styles (B)	1	81.045	81.045	1.666	0.204
AB	1	32.618	32.618	0.67	0.4177
Error	40	1945.913	48.648		

The AB Incidence table on Y: time on searching for a topic

	Dependent	Independent	Totals:
Meta	n=11 mean=11.282	n=11 mean=6.845	n=22 mean=9.064
Non-Meta	n=11 mean=7.1	n=11 mean=6.107	n=22 mean=6.604
Totals:	n=22 mean=9.191	n=22 mean=6.476	n=44 mean=7.384

*time (seconds) deveoted to searching for a topic on main menu level

Table VI: Effects on the monitoring guidance

ANOVA table for a 2-factor Analysis of Variance on Y

Source	DF	Sum of Squares	Mean Square	F-test	P value
Treatment (A)	1	29.455	29.455	1.659	0.205
cognitive Styles (B)	1	56.818	56.818	3.199	0.081
AB	1	2.273	2.273	0.128	0.7224
Error	40	710.364	17.759		

Table VI: Effects on the monitoring guidance (continued)

The AB Incidence table on Y: monitoring guidance

	Dependent	Independent	Totals:
Meta	n=11 mean=7.717	n=11 mean=5	n=22 mean=6.364
Non-Meta	n=11 mean=5.636	n=11 mean=3.818	n=22 mean=4.727
Totals:	n=22 mean=6.682	n=22 mean=4.409	n=44 mean=5.545

*frequent check of guided questions and mission

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APPENDIX I

MAIN INFORMATION LEVEL

Key Questions	Leaders	Negotiations
Years Leading to War	Special Events of '41	1941 Calendar
Messages (U.S.)	Newspapers	Telegrams (Secret)
Hawaii Defenses	Maps	Japanese Battle Plans
Winds Codes	Japanese consulate in Hawaii	Attack Damages
FBI Hawaii	Doctrine of Military command	U. S. Intelligence
British Intelligence	Major Inquiries	DONE

APPENDIX II

APPENDIX II (continued)

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